Hydro geochemical characterization of groundwaterin and around Meerut City of Uttar Pradesh, IndiausingWaterQuality Indices

A SYNOPSIS

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By

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EnrollmentNumber:

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DECLARATION

The research work embodied in this synopsis entitle **"Hydro geochemical characterization of groundwater in and around Meerut City of Uttar Pradesh, India using Water Quality Indices**" will be carried out in the laboratory of School of Basic sciences & Technology, IIMT University, Meerut. The work is original and has not been submitted in part or full for any degree or diploma of this or any other University.

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1. INTRODUCTION

Water is of utmost important forboth plants and animals as it make a significant portion oftheir body weight (Ahamad et al., 2023). The groundwater is less than one percent of the total water on Earth. Water is required for industrial activities, agricultural sector,commercialsector,andresidentialsector.Once water is available on Earth, human survival becomes conceivable. As per the predictions, the per capitawaterdemandwillincreasetoabout50%till2025(from31to46M^3/person/year)and100%till2050(from31to62m^3/person/year).Howeverpercapitaavailabilityofwateriscontinuouslydecreasingin India(IWMI,2007;ChaudharyandChaudhary,2012;Ibrahim*etal.,* 2020). The increasing per capita water demand and decreasing availability is a matter ofconcern.

India is now ranked first in terms of population. To supply the essential needs of so many different individuals, the industrial sector and agriculture sector is continuously growing. Both the sectorneeds water in huge quantity and thereafter release the huge quantityof wastewater afterprocessing. The runoff from agriculture fields contains the remains of fertilizers and pesticides.Thewastewaterfromindustrialsectorcontainsdifferentheavymetalsandorganicandinorganic wastes. In developing countries like India, Due to a lack of resources and expertise, the wastewater treatment process fails to work effectively. Urbanization provides lavish life due towhichahugequantityofwastewaterreleasedforurbancentres.Duelackofwastewatertreatment facilities and inefficient system of wastewater treatment, Wastewater gets released in both unprocessed and partially treated forms into surface water bodies or straight onto the ground (Kumar *et al.,* 2018; Ruhela*et al.,* 2020; Bhutiani*et al.,* 2021). Therefore two problemsare rising simultaneously. Uncontrolled abstraction is giving rise to low level of water table anddumping of wastewater is giving rise to the problem of water pollution. At present most of thesurface water bodies are polluted in India die to direct dumping of wastewater and groundwateris also becomes polluted due to leaching of pollutant through the soil strata (Bhutiani andAhamad,2018; Saleh *etal.,* 2020).

Drinking water that has been contaminated giving rise to health issues globally (Li and Wu, 2019). About 2million people worldwide are living without the access of safe and clean drinking water (WHO,2018)and 75.8 million inIndiaonly(Singh *et al.,*2012; Prasad *etal.,* 2021).

Sustainable development goal 3 emphasize on good health and wellbeing while 6 oncleanwaterandSanitationbutconsideringthepresentsituation,thewholeworldislackinginachievingboth thegoals.

StatusofMeerut

Ifthewidespreadgroundwaterpollutionkeepshappeningatthecurrentrate,thecityisprobably going to face its greatest water problem to date. Kharkhauda, Rajpura, Machchra, andthree blocks of Meerut have previously been designated as sensitive zones. Machchra is a darkzone among them, indicating that the top layer of groundwater is unfit for human consumption.Duetothiscircumstance,thecity'secologyisdeteriorating,andseriousheathrisksareemerging.Inadditiontobeingessentialtoproperhygieneandsanitation,enoughreadilyavailable,drinkablewater is alsoessential to the wellbeing ofthehome.

The intended research will therefore attempt to document the groundwater quality of the chosen study area. Furthermore, using the data we have gathered, we will compute the water quality and health risk indices.

2. LITERATURESURVEY

After assessing the groundwater quality in Kinauni hamlet in Meerut city, Kumar et al. (2011) came to the conclusion that the water was unfit for human consumption. The levels of manganese, iron, lead, and cadmium were found to be higher than the usual limit by the authors. Chaudhary and Chaudhary(2012) also reported the similar results of groundwater in the villages located near Kali eastriver.

Rajmohan and Amarasinghe (2016) studied the issues related to groundwater quality and theirpossiblesolutionsintheRamgangaSub-basin.Theauthorsreportedthehighervaluesofsulphate,nitrateandmanganeseinthegroundwater.In their 2018 study, Kumar et al. examined the Delhi-NCR region's groundwater quality. According to the authors, some of the factors contributing to the deterioration of groundwater quality include excessive abstraction, changes in the land use and land cover (LULC) pattern, and, of course, climate change.According to Rawat et al. (2018), who used numerical indices to study the groundwater quality of Delhi's Dwarka, there are some regions where the water is unfit for human consumption.

The suitability of groundwater quality in the semi-arid southern Indian region has been examined by Sridevi et al. (2019). Because TDS and other water quality indices were higher than average, the authors came to the conclusion that the water was unfit for irrigation. The levels of heavy metals in Mathura, Uttar Pradesh's groundwater and their geo-accumulation were assessed by Ahmed et al. (2019).Ahmad *et al.* (2019) also studied the groundwater quality of Mathura city and concluded thatmost of the samples were moderately polluted. Malyan*et al.* (2019) wrote a review on thecarcinogenicpollutantsinaquaticecosystemswithspecialreferencetogroundwater.Theauthors concluded that the value of group I carcinogens exceeds the permissible limits. Adithya*etal.*(2019)studiedtheoccurrenceofUraniumingroundwater.Kumar*etal.*(2019a)performed the assessment of trace elements in the groundwater of Saharanpur District of UPfound that the concentration of iron and mercury exceeds the permissible limits. Iron is alsocausing potent health hazards to the population. Kumar *et al.* (2019b) performed the assessmentof underground water of Meerut District of UP found that majority of the samples were suitablefordrinking and irrigation purpose.

In addition to working on China's groundwater quality, Ji et al. (2020) processed the data needed to calculate HRI. According to the authors, the majority of the sites had good

groundwater quality. They simultaneously disclosed the non-carcinogenic dangers because of the existence of Arsenic, fluoride, and chromium. The Meerut region's groundwater quality during the last 20 years and the effects of its decline were examined by Sharma et al. (2020). Saleh et al. (2020) used the water quality index and other multivariate statistical approaches to investigate the quality of groundwater in a few Iranian cities. The quality of the groundwater in Mathura, Uttar Pradesh, was investigated by Ahmed et al. (2020). Higher TDS, calcium, magnesium, and chloride levels in groundwater were reported by the authors. The CCME WQI value indicates how good or bad the water quality is in the study area. Pandey et al. (2020) studied groundwater quality in Allahabad city, UP using WQI and GIS. The authors concluded that the water quality at most sites was suitable for drinking.

Bhutiani*et al.* (2021)worked the groundwater quality ofLaksar block ofHaridwar.Theauthors observed the values of Hardness and iron above the standard values of world healthorganization (WHO). The authors observed the higher values of all the selected parameters at asitewhichislocatednearindustrialclusterthereforetheauthorsconcludedthatindustrialization affects the groundwater quality and recommended the disposal of industrialeffluent after proper treatment. Ansari *et al.* (2021) performed the groundwater modelling ofMeerut city. The developed model predicted the groundwater table rise in rural areas due to theuse of sustainable irrigation technologies. Ali *et al.* (2021) assessed the groundwater quality ofAgra region with special reference to Fluoride and the values between 0.15 to 2.50 mg/l.Fluoridevalueswerefound beyond the limitsin 60%of thesamples.

The effect of intensive farming practices on the Ganga-Ramganga Basin's groundwater quality was investigated by Pradhan et al. in 2021. The results led the authors to the conclusion that the groundwater quality has deteriorated in 92% of the block. The amount of arsenic in the Saran district of Bihar's groundwater as well as mitigation strategies were investigated by Kumar et al. (2021a). In the Saran area of Bihar, Kumar et al. (2021b) investigated the quality of the groundwater and noted the drinking water range. Prasad et al. (2021) assessed drinking water quality in Alappuzha district of southern Kerala.Theauthorsreportedthevalueofstudiedphysicochemicalparameters within the permissible limit but certain microbial contamination was detected in thearea. Krishan *et al.*(2021) performed the Hydrogeochemical assessment of a semi-arid regionof Haryana and concluded that sodium, calcium and chloride were the dominant ions in thegroundwater.Theauthors concluded that rockweathering,evaporation and ionsexchangeprocesses weremajor causeofincreasedsalinity inthearea andwhilethe anthropogenic

factorswereworkingascatalyst.The water quality index (WQI) was used by Ram et al. (2021) to evaluate the groundwater quality in the Mahoba district of Uttar Pradesh. Except for a few spots, the majority of the places had drinking water quality that the authors could observe. Using the water quality index (WQI) and a geographic information system (GIS), Jurassic et al. (2021) investigated the groundwater quality in a number of Uttar Pradesh districts.

In the Sahibabad to Meerut zone, Ruhela et al. (2022) investigated the groundwater quality at several locations and found that the values of TDS and hardness are above the standard values of WHO andBIS. Salinity problem was also identified by the authors in the area which may be due highirrigationactivityinthearea.Fluoride levels in the Yamuna floodplain ranged from 0.18 to 1.57 mg/L, according to a study by Ali et al. (2022) on the non-carcinogenic health risk assessment caused by groundwater fluoride exposure. Children have a higher risk of developing non-cancer diseases, according to the study's findings. According to Khan et al.'s (2022) investigation on groundwater quality and health risk assessment at Ramsar sites, the water is naturally alkaline and hard. There were also reports of elevated nitrate levels in the region as a result of nitrogenous fertilizer leaching.

Bojago*et al.* (2023) studied the spatio temporal variation in drinking water quality of Ethiopia.The authors found the values of total suspended solids (TSS), total solids (TS), cadmium (Cd)andIron(Fe)aboveabovethestandardvaluesofWHO.Theauthorsrecommendedthesedimentation and filtration process to treat the water to obtain the required quality of drinkingwater. The water quality in the districts of Muzaffarnagar, Baghpat, Ghaziabad, and Gautam Buddha Nagar was found to be significantly damaged by salts and nitrate, according to Gautam and Rai's (2023) hydrogeochemical study of groundwater in certain areas of Meerut. Groundwater quality of India's arid and semi-arid states, as well as the ongoing decline in groundwater quality throughout the country, were reported by Ahmed et al. in 2023. The authors also noted non-carcinogenic concerns because of the presence of heavy metals, nitrate, and fluoride. Sajib et al. (2023) used WQI and GIS to evaluate the quality of the groundwater in Lucknow, Uttar Pradesh. According to the authors' findings, most locations had drinkable water..

3. SCIENTIFICGAPS:

Fromthereviewofliterature,wereachedonthefollowingconclusion -

- Meerutisanintenseagriculturaldistrictandthereforethereisaprobabilityofboththequality and quantity degradationof groundwater.
- Thereisalackof groundwaterqualitystudiesconducted intheselectedarea.Contamination.

4. OBJECTIVES

- Based on physicochemical and heavy metal features, the current study aims
- To evaluate the groundwater quality of the chosen sites.
- To identify whether groundwater is suitable for irrigation and drinking using several indicators.
- To measure heavy metal contamination's impact on the health risk index (HRI).

5. METHODOLOGY(Materials &Methods)

Studyarea

TheareaselectedfortheproposedstudyistheMeerutcity.TheMeerutcityliesbetweenthe29˚01´Nlatitudeand77˚45´Elongitude.Atpresentthepopulationofthecityisabout 3.4millions.Allthe selected sitesaregiven intable 1.

Table1:Selectedstudysites.

SamplingsiteCode	SamplingsiteName	Co-ordinates

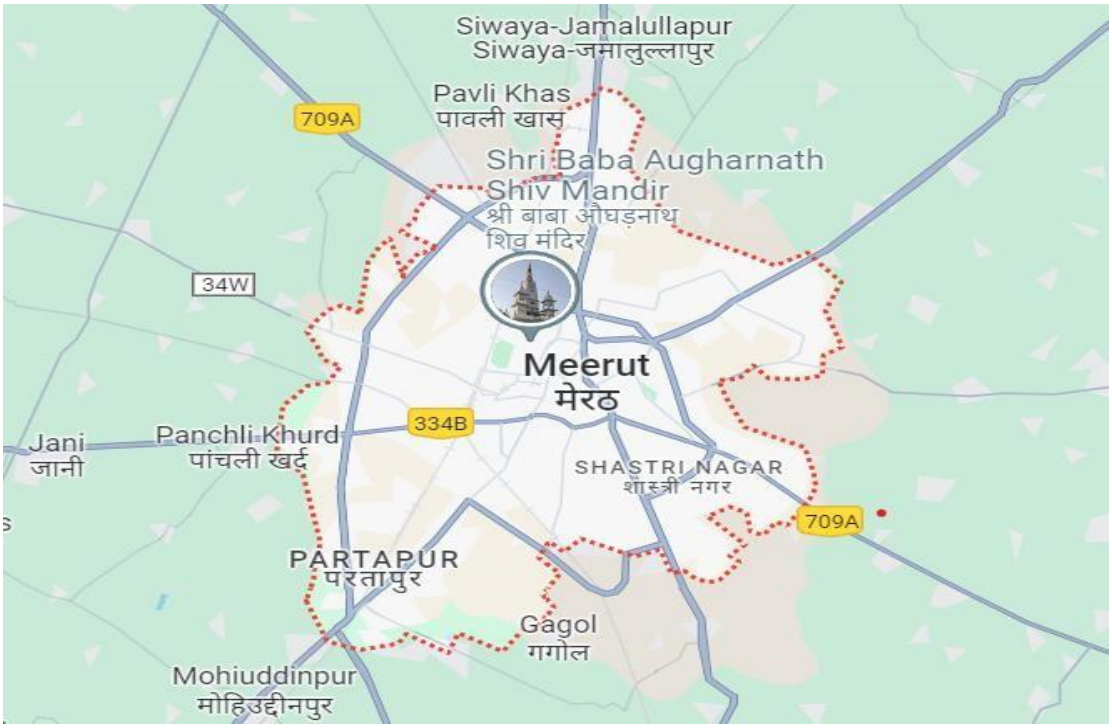

Figure1:Googleearthmapshowingtheselectedsites.

SamplingandAnalysis

- Thesampleswillbecollectedfromtheselectedsamplingsites(Table1)onceinthreemonthsin prewashed plasticcontainers of2 litrecapacity.
- Temperatureand pH ofthesamples willbeanalyzed atthesampling sites.
- Thesampleswillbetransferredtothelaboratoryfortheanalysisoftherestoftheparameters.
- Thesampleswill beanalyzed followingthestandardmethodologies ofAPHA(2012).
- Afterthecollectionofthedata,therequiredsoftwarewillbeusedforthecalculationofWQI,HRI and spatio-temporal variations.

Table2:SelectedParameters.

Physicochemicalparameters	
1	TotalDissolvedSolids (TDS)
2	ElectricalConductivity (EC)
3	pH
4	Totalhardness (TH)
5	Calcium (Ca)
6	Magnesium (Mg)
7	Carbonate(CO_3^{2+})
8	Bicarbonate(HCO_3^-)
9	Chloride (Cl)
10	Sulphate (SO_4^{2-})
11	Nitrate(NO_3^-)
12	Fluoride(F)
HeavyMetals	
1	Arsenic(As)
2	Lead(Pb)
3	Cadmium (Cd)

6. BIBLIOGRAPHY/REFERENCES:

Adithya, V. S., Chidambaram, S., Keesari, T., Mohokar, H. V., &Prasanna, M. V. (2019).Occurrenceofuraniumingroundwateralongthelithologicalcontactsincentral Tamil nadu, India: an isotope hydrogeochemical perspective. Exposure and health, 11,277-290.

Ahamad, F., Tyagi, S. K., Singh, M., & Sharma, A. K. (2023). Groundwater in Arid and Semi-aridRegionsofIndia:AReviewontheQuality,ManagementandChallenges.Groundwater in Arid and Semi-Arid Areas: Monitoring, Assessment, Modelling, andManagement,11-52.

Ahmad,S.,Umar,R.,&Arshad,I.(2019).Groundwaterqualityappraisalanditshydrogeochemical characterization—Mathura City, Western Uttar Pradesh. Journal oftheGeological Society ofIndia, 94, 611-623.

Ahmed, S., Khurshid, S., Madan, R., Amarah, B. A. A., &Naushad, M. (2020).Water qualityassessmentofshallowaquiferbasedonCanadianCouncilofMinistersoftheenvironment index and its impact on irrigation of Mathura District, Uttar Pradesh.Journalof King Saud University-Science, 32(1), 1218-1225.

Ahmed, S., Khurshid, S., Qureshi, F., Hussain, A., & Bhattacharya, A. (2019). Heavy metalsandgeo-accumulationindexdevelopmentforgroundwaterofMathuracity,UttarPradesh.Desalination and WaterTreatment, 138,291-300.

Ali, S., Khan, S. U., Gupta, S. K., Sinha, A., Gupta, M. K., Abbasnia, A., &Mohammadi, A. A.(2021).Healthriskassessmentduetofluorideexposurefromgroundwaterinruralareas of Agra, India: Monte Carlo simulation. International journal of environmentalscience and technology,1-12.

Ali, S., Shekhar, S., & Chandrasekhar, T. (2022).Non-carcinogenic health risk assessment offluorideingroundwateroftheRiverYamunafloodplain,Delhi,India.InComputersinEarth and Environmental Sciences (pp. 455-466).Elsevier.

Ansari, A. H. M., Umar, R., Us Saba, N., & Sarah, S. (2021). Assessment of current and futuregroundwater stress through varied scenario projections in urban and rural environmentinpartsofMeerutdistrict,UttarPradeshinGangessub-basin.JournaloftheGeologicalSociety ofIndia, 97, 927-934.

Bhutiani,R.,&Ahamad,F.(2018).Efficiencyassess-mentofsandintermittentfiltrationtechnologyforwastewatertreatment.InternationalJournal ofadvanceresearchinscience and engineering (IJARSE), 7(03), 503-512.

Bhutiani, R., Ahamad, F., & Ram, K. (2021). Quality assessment of groundwater at Laksarblock, Haridwar in Uttarakhand, India using water quality index: a case study. JournalofApplied and Natural Science, 13(1), 197-203.

BIS (2012). Indian standard drinking water specification, Second Revision ISO: 10500:2012,Bureau of Indian Standards (BIS), Drinking Water Sectional Committee, FAD25. NewDelhi,India.

Bojago, E., Tyagi, I., Ahamad, F., &Chandniha, S. K. (2023). GIS based spatial-temporaldistribution of water quality parameters and heavy metals in drinking water: Ecologicaland health modelling. Physics and Chemistry of the Earth, Parts A/B/C, 130, 103399.https://doi.org/10.1016/j.pce.2023.103399

Chaudhary,R.,&Chaudhary,V.(2012).Assessmentofcationiccompositioningrounddrinkingwaterinsomepartsof Meerutdistrict,UttarPradesh,India.*ProgressiveAgriculture*,*12*(2), 376-380.

Chaurasia, A. K., Pandey, H. K., Tiwari, S. K., Pandey, P., & Ram, A. (2021). Groundwatervulnerabilityassessmentusingwaterqualityindex(WQI)undergeographicinformationsystem(GIS) frameworkinpartsof Uttar Pradesh,India.SustainableWaterResources Management, 7(3), 40.

Gautam, A., & Rai, S. C. (2023).Hydrogeochemical characterization and quality assessment ofgroundwater resources in the Upper-Doab region of Uttar Pradesh, India.*Frontiers inEnvironmentalScience*,*11*, 1193979.

Ibrahim, K. A. I., Ahmed, S. I. A., El-Gendy, A. S., &Sabry, T. I. M. (2020). Effect of MediaPropertiesonPer-formanceofSandFiltrationforDrainWaterTreatment.www.preprints.org,doi:10.20944/preprints202003.0112.v1

IWMI (2007). India's water future to 2025-2050: Business-as-usual scenario and deviations.Colombo,SriLanka:InternationalWaterManagementInstitute(IWMI).(IWMI ResearchReport 123).

Ji, Y., Wu, J., Wang, Y., Elumalai, V., &Subramani, T. (2020).Seasonal variation of drinkingwater quality and human health risk assessment in Hancheng City of Guanzhong Plain,China.Exposureand health, 12, 469-485.

Khan, I., Umar, R., &Izhar, S. (2022). Hydrogeochemical and health risk assessment in andaround a Ramsar-designated wetland, the Ganges River Basin, India: Implications fornatural and human interactions. Environmental Monitoring and Assessment, 194(7),483.

Krishan, G., Sejwal, P., Bhagwat, A., Prasad, G., Yadav, B. K., Kumar, C. P., ...&Muste, M.(2021).Roleofionchemistryandhydro-geochemicalprocessesinaquifersalinization—a case study from a semi-arid region of Haryana, India. Water, 13(5),617.

Kumar, A., Kumar, R., Rahman, M. S., Ali, M., Kumar, R., Nupur, N., ...& Ghosh, A. K.(2021a). Assessment of arsenic exposure in the population of Sabalpur village of SaranDistrictofBiharwithmitigationapproach.EnvironmentalScienceandPollutionResearch,28,43923-43934.

Kumar, A., Kumar, S., Dhyani, B. P., Kumar, A., Shahi, U. P., Vivek, R. K., & Dubey, D. V.(2019b). Assessment of underground water quality for drinking and irrigation purposeon west side of the Ganga canal command area in Meerut district of Uttar Pradesh,India.*IJCS*, *7*(2), 304-310.

Kumar, A., Malyan, S. K., Kumar, S. S., Dutt, D., & Kumar, V. (2019).An assessment of traceelement contamination in groundwater aquifers of Saharanpur, Western Uttar Pradesh,India.Biocatalysis and agricultural biotechnology, 20,101213.

Kumar, A., Shahi, U. P., Dhyani, B. P., Naresh, R. K., Singh, B., Kumar, Y., &Sardar, S.(2011). Quality assessment of ground water in PMDE treated farm land for drinkingpurpose.*Plant Archives*,*11*(1), 187-191.

Kumar, N., Alam, M. A., & Srivastava, K. (2021b). Physicochemical and MicrobiologicalAnalysis of Groundwater OfSonepur Subdivision Of Saran District Of Bihar, India.PollutionResearch, 40: S81-S89.

Kumar, S., Sarkar, A., Ali, S., &Shekhar, S. (2018). Groundwater system of national capitalregionDelhi,India. Groundwaterof South Asia, 131-152.

Li, P., & Wu, J. (2019).Drinking water quality and public health. Exposure and Health, 11(2),73-79.

Malyan,S.K.,Singh,R.,Rawat,M.,Kumar,M.,Pugazhendhi,A.,Kumar,A.,...&Kumar,S. S.(2019).AnoverviewofcarcinogenicpollutantsingroundwaterofIndia.Biocatalysisand Agricultural Biotechnology, 21, 101288.

Pandey, H. K., Tiwari, V., Kumar, S., Yadav, A., & Srivastava, S. K. (2020).GroundwaterqualityassessmentofAllahabadsmartcityusingGISandwaterqualityindex.SustainableWaterResources Management, 6, 1-14.

Pradhan,S.,Kumar,S.,Kumar,Y.,&Sharma,H.C.(2021).Implicationofintensiveagricultureongroundwaterutilizationin Ganga-Ramgangainterbasin,India.EnvironmentalEarth Sciences, 80(9), 342.

Prasad, G., Reshma, A. S., & Ramesh, M. V. (2021). Assessment of drinking water quality onpublichealthatAlappuzhadistrict,southernKerala,India.MaterialsToday:Proceedings,46, 3030-3036.

Rajmohan, N., &Amarasinghe, U. (2016).Groundwater quality issues and management inRamgangaSub-Basin. Environmental Earth Sciences, 75(12),1-14.

Ram, A., Tiwari, S. K., Pandey, H. K., Chaurasia, A. K., Singh, S., & Singh, Y. V. (2021).Groundwaterqualityassessmentusingwaterqualityindex(WQI)underGISframework.Applied WaterScience, 11, 1-20.

Rawat, K. S., Tripathi, V. K., & Singh, S. K. (2018). Groundwater quality evaluation usingnumericalindices:acasestudy(Delhi,India).SustainableWaterResourcesManagement,4, 875-885.

Ruhela, M, Wani, A. A., &Ahamad, F. (2020). Efficiency of Sequential Batch Reactor (SBR)basedsewagetreatmentplantanditsdischargeimpactonDalLake,Jammu&Kashmir, India. Archives of Agriculture and Environmental Science, 5(4), 517-524,https://dx.doi.org/10.26832/24566632.2020.0504013

Ruhela, M., Jhariya, P., Bhardwaj, S., &Ahamad, F.(2022).Assessment of groundwaterquality from Sahibabad to Modinagar Meerut Uttar Pradesh, India using water qualityindex.EnvironmentConservationJournal,23(3),160-167. https://doi.org/10.36953/ECJ.15522455

Saleh, H. N., Valipoor, S.,Zarei,A.,Asghari, M.Y. F.B.,Mohammadi,A.A., Ghalehaskar,F. A.S.,&Khaneghah,A.M.(2020).Assessmentofgroundwaterqualityaroundmunicipal solid waste landfill by using Water Quality Index for groundwater resourcesand multivariate statistical technique: A case study of the landfill site, QaemShahrCity, Iran. Environ Geochemistry Health, 42, 1305-1319. https://doi.org/10.1007/s10653-019-00417-0

Saqib, N., Rai, P. K., Kanga, S., Kumar, D., Đurin, B., & Singh, S. K. (2023). Assessment ofGround Water Quality of Lucknow City under GIS Framework Using Water QualityIndex(WQI).Water, 15(17), 3048.

Sharma, D. K. (2020). Prospects and Consequences of Depletion of Groundwater in MeerutDistrict1998 to 2016. InternationalJournal of Management, 11(9).

Singh, J., Kumar, A., Dhyani, B. P., Shahi, U. P., Singh, R. R., & Kumar, Y. (2012).QualityAssessmentofGroundWaterforIrrigationandDrinkingPurposeinMeerutDistrict.*ProgressiveAgriculture*, *12*(1), 203-208.

Sreedevi,P.D.,Sreekanth,P.D.,Ahmed,S.,&Reddy,D.V.(2019).Evaluationofgroundwater quality for irrigation in a semi-arid region of South India. SustainableWaterResources Management, 5(3), 1043-1056.

WHO(2011).Guidelinesfordrinking-waterquality,4thedn.WorldHealthOrganization,Geneva.

WHO,2018.Drinking-water.WorldHealthOrganizationfactsheets.https://www.who.int/en/news-room/fact-sheets/detail/drinkingwater.(Accessed3January2023).